CEMENT GROUTED ROCK BOLTS

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INTRODUCTION

- Bolting Principles
- Critical Parameters
- Types of Bolts
- Grouting
- Mechanism of Fully Grouted Rock Bolts
- Effect of Water/Cement Ratio
- Types of Cement Grouted Rock Bolts
- How to Install Cement Grouted Rock Bolts
- Conclusion
What is the Bolt System Designed to do?

Rock bolts are used as the main support for structures such as tunnels and mines where safety is critical.

- Beam building
- Suspension
- Keying
- Surface control - natural arch
Beam Building

Support Principles

**Laminated Strata**

Individual laminations bound together to form a single beam
Competent Strata

Weak Strata

Suspended layer

Anchorage Zone

Support Principles
Surface Control

Highly jointed, altered or weathered rock
Critical Parameters

- **Bolt Type**
- **Strength**
  - Grade
  - Diameter
- **Length**
- **Density (spacing)**
- **Plate**
Types of Bolts

- Friction Anchored
- Mechanical
- Fully Grouted
- Tensioned Rebar
- Combination/Point Anchored
- Mechanically Anchored/Resin Assisted
A number of different grout materials are used depending on the size of the opening and the amount of the inflow.

Grouts generally; such as micro-fine or ultra-fine cements and/or sodium silicate can be injected.
MECHANISMS OF FULLY GROUTED BOLTS

- Low plate loads
- High anchorage developed along bolt length
- High shear resistance along resin/rock interface
- Little or no shear resistance along slips and joints unless intersected by bolt
- No clamp loads

LOW PLATE LOADS

HIGH ANCHORAGE DEVELOPED ALONG BOLT LENGTH

HIGH SHEAR RESISTANCE ALONG RESIN/ROCK INTERFACE

LITTLE OR NO SHEAR RESISTANCE ALONG SLIPS AND JOINTS UNLESS INTERSECTED BY BOLT

NO CLAMP LOADS
## TEST RESULT

<table>
<thead>
<tr>
<th>Bolt Diameter db(mm)</th>
<th>Bolt Length Lb(cm)</th>
<th>Tensile Strength (kg)</th>
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<tbody>
<tr>
<td>10</td>
<td>24,2</td>
<td>4320</td>
</tr>
<tr>
<td>12</td>
<td>24,2</td>
<td>5470</td>
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<td>16</td>
<td>24,2</td>
<td>7360</td>
</tr>
<tr>
<td>18</td>
<td>24,2</td>
<td>8160</td>
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The graph on the right shows the relationship between Bolt Diameter and Tensile Strength.
High speed cement grout mixers are commonly used which can reasonably ensure uniform mixing between grout and water.

The grout should be readily pumpable without being too fluid and a typical water/cement ratio of 0.35 to 0.40 is a good starting point for a grout mix for rock bolting.
Water/cement ratio of 0.35 to 0.4 are significantly better than those with ratios in excess of 0.5.
WATER/CEMENT RATIO

Graph showing the relationship between Water/cement ratio and Deformation modulus - GPa, and Uniaxial compressive strength - MPa.
It is most important to ensure that the annular space between the bolt and the drillhole wall is completely filled with grout.
Types of Cement Grouted Rock Bolts

Standard Soil Nail

1. Domed plate
2. Domed nut
3. Threadbar
4. Cement grout
Types of Cement Grouted Rock Bolts

DCP-Soil Nail

1. Domed plate
2. Domed nut
3. Threadbar
4. Cement grout
5. Corrugated sheathing
6. Spacer
7. Grout cap
Types of Cement Grouted Rock Bolts

Expansion Shell Anchor

1. Dished plate
2. Domed anchor nut
3. Threadbar
4. Cement grout
5. Expansion shell
Types of Cement Grouted Rock Bolts

SN-Anchor

1. Anchor plate
2. Hex nut
3. Threadbar
4. Cement grout
Types of Cement Grouted Rock Bolts

- CT-Bolt
  1. Anchor nut
  2. Dome – shaping grouted adapter
  3. Polyethylene sleeve
  4. Bolt plate
  5. Rebar rock bolt
  6. Expansion shell
SLOPE STABILITY FAILURE
How to Install CGRB

1. Drill holes as perpendicular as possible to hanging wall.
2. Remove the plastic sleeve covering the Expansion Shell.
3. Insert the GV bolt into the hole.
4. Push the GV Bolt into the hole until the washer touches the hanging wall.
5. Tension the bolt using suitable equipment.
7. Load Indicator After Tensioning.
8. Prepare the grout to fill the hole to the correct texture/property for the relevant grout supplied.
9. Pump the grout into the hole. Remove the clip-on connector when hole is filled with grout.
10. Attach the pump nozzle.
Production – Installation of Cement Grouted Rock Bolts
Advantages of Cement Grouted Rock Bolts

Selection of the appropriate cement anchoring grout can provide many of the following advantages:

- Rapid strength gain
- Excellent pumpability
- Durability of high strength and low porosity for long term life
- Resistance to high saline and acidic ground water shrinkage compensated.
Conclusion

- CGRB are the ideal instrument to support high-medium stiffness zones.
- Cement grouted rock bolts reaches optimum strength in few days.
- CGRB are used mainly permanently supporting.
- Cheap and simple application process.
Stability control can be provided during the tunneling operations by making correct estimations and taking prompt decisions.